

# An Outbreak of *Plasmodium vivax* Malaria among US Soldiers Returning from Afghanistan

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# Outline

- Background
- Outbreak investigation methods
- Results
  - Epidemiologic
  - Clinical
  - Primaquine intervention
- Conclusions



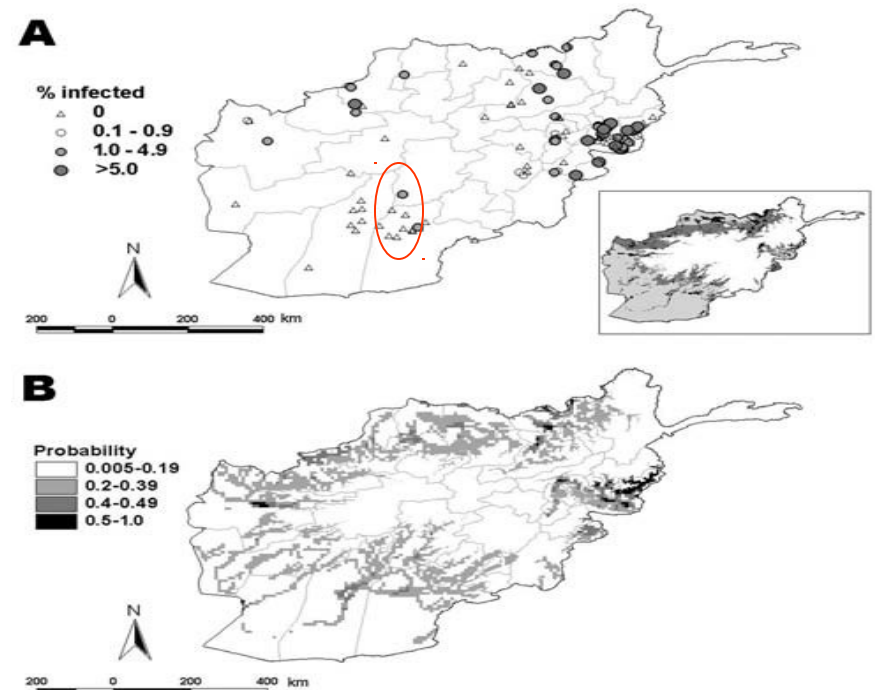
# Malaria Outbreaks among US Military Personnel Returning from OEF

- US Army Rangers deployed 2002\*
  - 38 cases (attack rate of 52 cases/1000 Soldiers)
  - Delayed clinical presentation (233 days after departing Afghanistan)
- 864th Engineering Combat Battalion (ECB) deployed 2005-2006

\*Kotwal et al. An Outbreak of Malaria in US Army Rangers Returning From Afghanistan. JAMA, January 12, 2005; 212-216.



# Location of Tarin-Kowt Road Construction

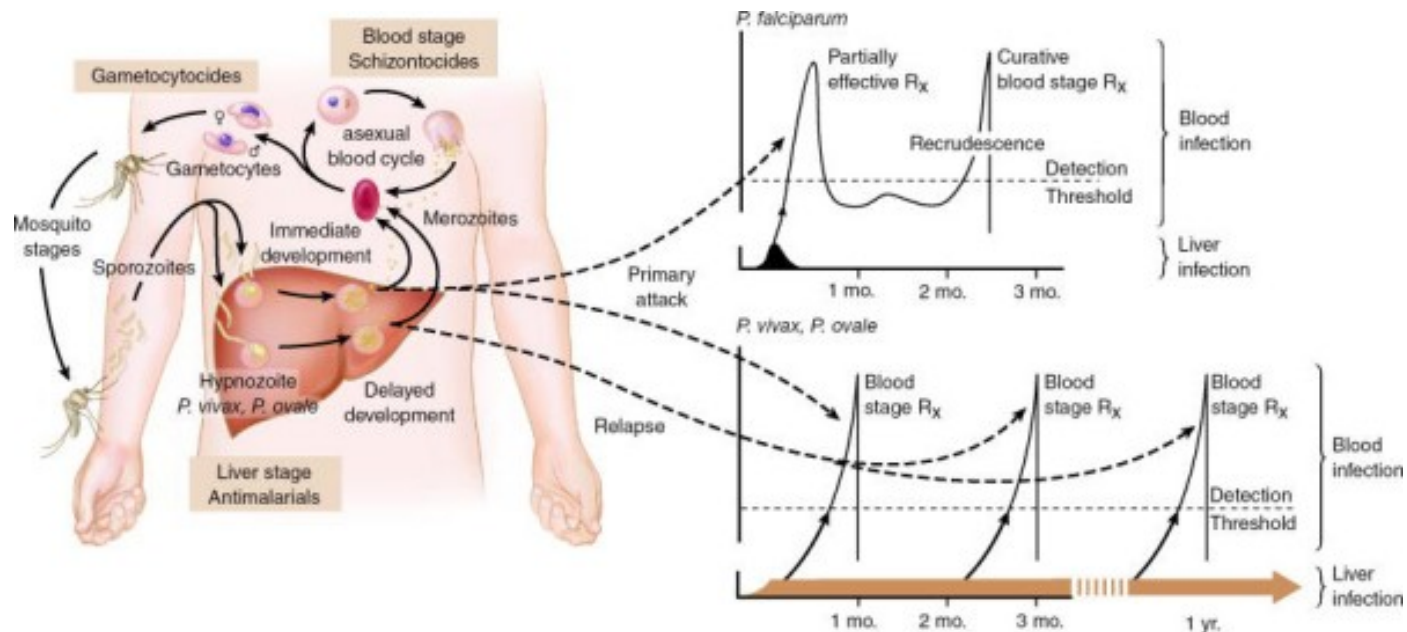


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# *P. vivax* Malaria Prevention

- Doxycycline, mefloquine, and atovaquone-proguanil are effective against blood stages
- Primaquine is the only drug available to kill the hypnozoite





# Outbreak Identification

- April 2006: cluster of *P. vivax* among 864<sup>th</sup> ECB detected through USACHPPM disease surveillance
- USACHPPM requests further investigation by preventive medicine at Fort Lewis and Fort Richardson
  - Reporting cases through the Army's Reportable Medical Events System
  - Publish findings



# Preliminary Findings as of June 2006\*

- 11 cases of *P. vivax* (smear-positive) malaria from 864th ECB at Fort Richardson
  - Delayed or missing primaquine prescriptions
  - Periods of doxycycline unavailability while deployed
  - Non-compliance with doxycycline
  - Minimal use of DEET, permethrin, and bed nets
  - Failure of leadership to enforce and emphasize prevention measures
- Full outbreak investigation initiated by MAMC Preventive Medicine

\*Reported in June 2006 by LTC Gavrilis, Preventive Medicine, Officer in Charge



# Study Population

- Deployed to Afghanistan with the 864<sup>th</sup> ECB
  - Headquarters and Support Company from Ft. Lewis, WA
  - Charlie Company from Ft. Richardson, AK
- In theater anytime between January 2005 and April 2006





# Data Collection and Analysis

- Standardized questionnaire designed by USACHPPM
  - Demographics
  - Deployment history
  - Personal protective measures and chemoprophylaxis
  - Primaquine compliance
  - Soldier attitudes about anti-malarial medicines
- On-site proctored questionnaire at Fort Lewis and Fort Richardson in fall 2006
- Review of available medical records
- Data entry and analysis in Epi Info



# Attack Rates

- Overall attack rate: 11% (35/330)
- Exposure to Construction Base Kodiak
  - Attack rate among all Soldiers: 19% (34/182)
  - Attack rate among Equipment Platoon: 53% (9/17)



# Characteristics of Survey Respondents

	<b>Case n (%)</b>	<b>Non-Case n (%)</b>	<b>Total n (%)</b>
Unit			
C	21 (68)	49 (28)	70 (40)
HSC	10 (32)	93 (54)	103 (60)
Pay grade			
E1-E4	14 (45)	68 (48)	82 (47)
E5-E9	16 (52)	62 (44)	78 (45)
Officer	1 (3)	12 (8)	13 (8)
Median age in years	23	24	24
Range	18-36	18-48	18-48
Median deployment in days	358	357	357
Range	169-378	70-371	70-378
<b>Total</b>	<b>31</b>	<b>142</b>	<b>173</b>



# Characteristics of Survey Respondents

	Case n (%)	Non-Case n (%)	Total n (%)	OR (95% CI)
Sex				
Male	28 (90)	111 (78)	139 (80)	2.6 (0.7-14.2)
Female	3 (10)	31 (22)	34 (20)	Ref
Race				
Non-black	29 (94)	105 (74)	134 (78)	5.0 (1.2-44.8)
Black	2 (6)	36 (26)	38 (22)	Ref
Reported smoking				
Yes	23 (74)	79 (56)	102 (59)	2.3 (0.9-6.1)
No	8 (26)	63 (44)	71 (41)	Ref
<b>Total</b>	<b>31</b>	<b>142</b>	<b>173</b>	

OR=odds ratio; CI=confidence interval; Ref=referent category



# Items Received Prior to Arrival in Afghanistan

- 66% Doxycycline
- 61% Bed nets and poles
- 35% Meta-N,N-diethyl toluamide (DEET)
- 10% Permethrin



# Doxycycline Compliance

	<b>Case n (%)</b>	<b>Non- Case n (%)</b>	<b>Total n (%)</b>
Some	6 (20)	56 (41)	62 (37)
Most	20 (67)	66 (48)	86 (52)
Fully	4 (13)	14 (10)	18 (11)
<b>Total</b>	<b>30</b>	<b>136</b>	<b>166*</b>

\*seven reported taking mefloquine instead of doxycycline

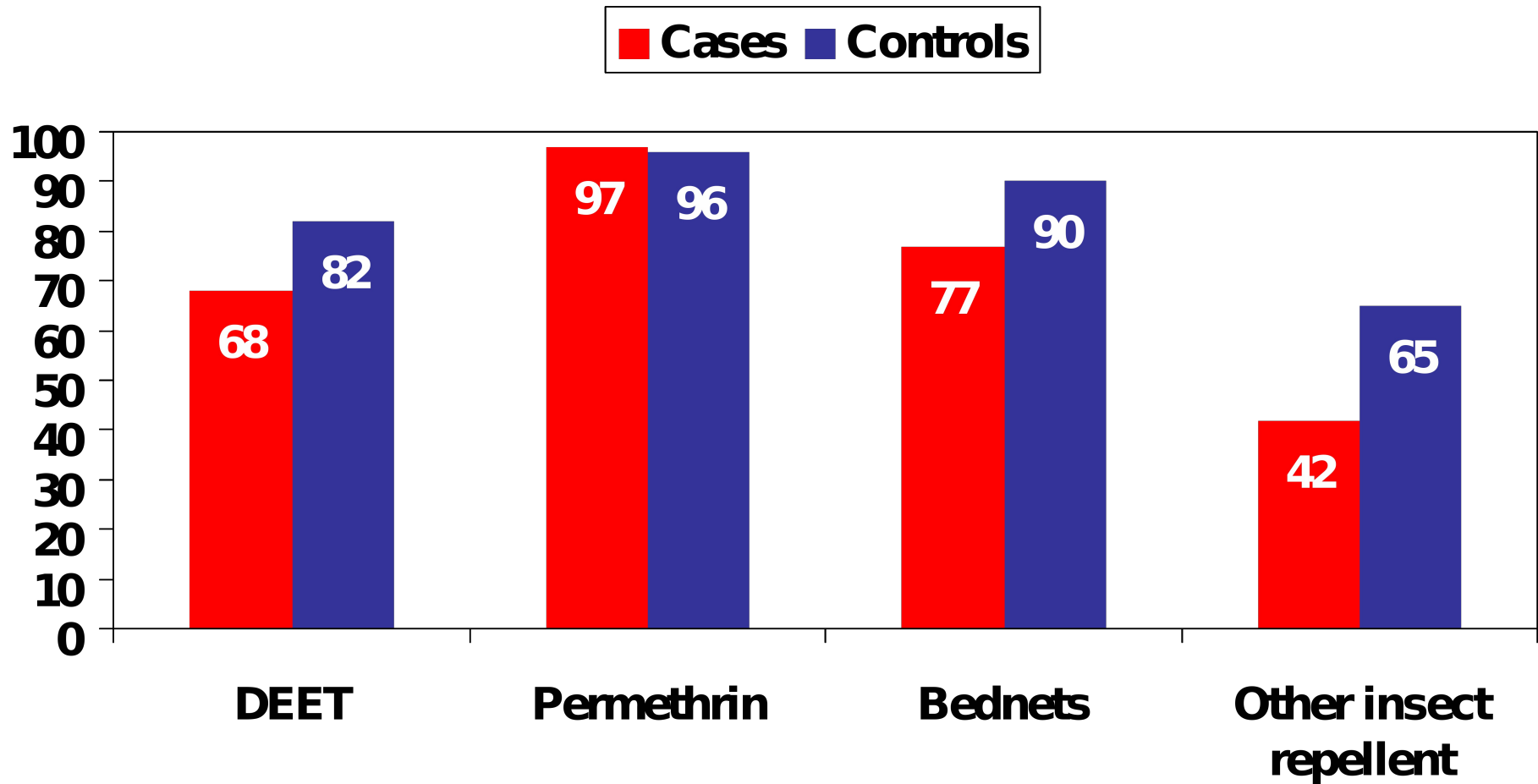


# Reasons for Doxycycline Noncompliance

	<b>Case n (%)</b>	<b>Non-Case n (%)</b>	<b>Total n (%)</b>
Forgot	12 (46)	51 (42)	63 (43)
Side effects	3 (12)	25 (20)	28 (19)
Ran out of pills	5 (19)	19 (16)	24 (16)
Did not have any	5 (19)	12 (10)	17 (11)
Not Important	0	8 (7)	8 (5)
Don't like pills	1 (4)	7 (6)	8 (5)
Other	1 (4)	1 (1)	2 (1)
<b>Total</b>	<b>26</b>	<b>122</b>	<b>148</b>



# Unused Personal Protective Measures\*



\*No more than two missing responses for each variable



# Primaquine (PQ) Compliance

	<b>Case n (%)</b>	<b>Non-Case n (%)</b>	<b>Total n (%)</b>
<b>Did not receive</b>	<b>12 (39)</b>	<b>60 (42)</b>	<b>72 (42)</b>
None	0	17 (11)	17 (10)
At least some	13 (42)	33 (23)	46 (27)
All	6 (19)	31 (22)	37 (21)
Total	31	142	172*

\*one missing response



# Reasons for PQ Noncompliance

	<b>Case n (%)</b>	<b>Non- Case n (%)</b>	<b>Total n (%)</b>
Forgot	9 (75)	24 (50)	33 (54)
Not important	0	9 (19)	9 (15)
Side effects	1 (8)	5 (10)	6 (10)
Did not have any or enough	1 (8)	4 (8)	5 (8)
Don't like pills	0	5 (10)	5 (8)
Lost pills	1 (8)	1 (2)	2 (3)
<b>Total</b> missing responses	<b>12</b>	<b>48</b>	<b>60*</b>



# Soldier Attitudes About Anti-Malarial Medicines

1. Clear instructions on how to take them: 95%
2. Did not work because Soldiers who took all of their pills got malaria anyway: 74%
3. Some Soldiers forgot to take them: 96%
4. Some Soldiers refused: 79%
5. Hard to keep up with pills because too many other things happening: 70%

Missing responses for each question in parentheses:

1 (3); 2 (13); 3 (5); 4 (9); 5 (6)



# Clinical Findings

- Plasmodium species
  - Vivax: 24
  - Unknown: 11
- Timing of diagnosis
  - After deployment: 24
  - During deployment: 7\*
  - Both: 4
- Delayed clinical presentation after leaving Afghanistan: 155 days

\*one was on R&R leave at time of diagnosis



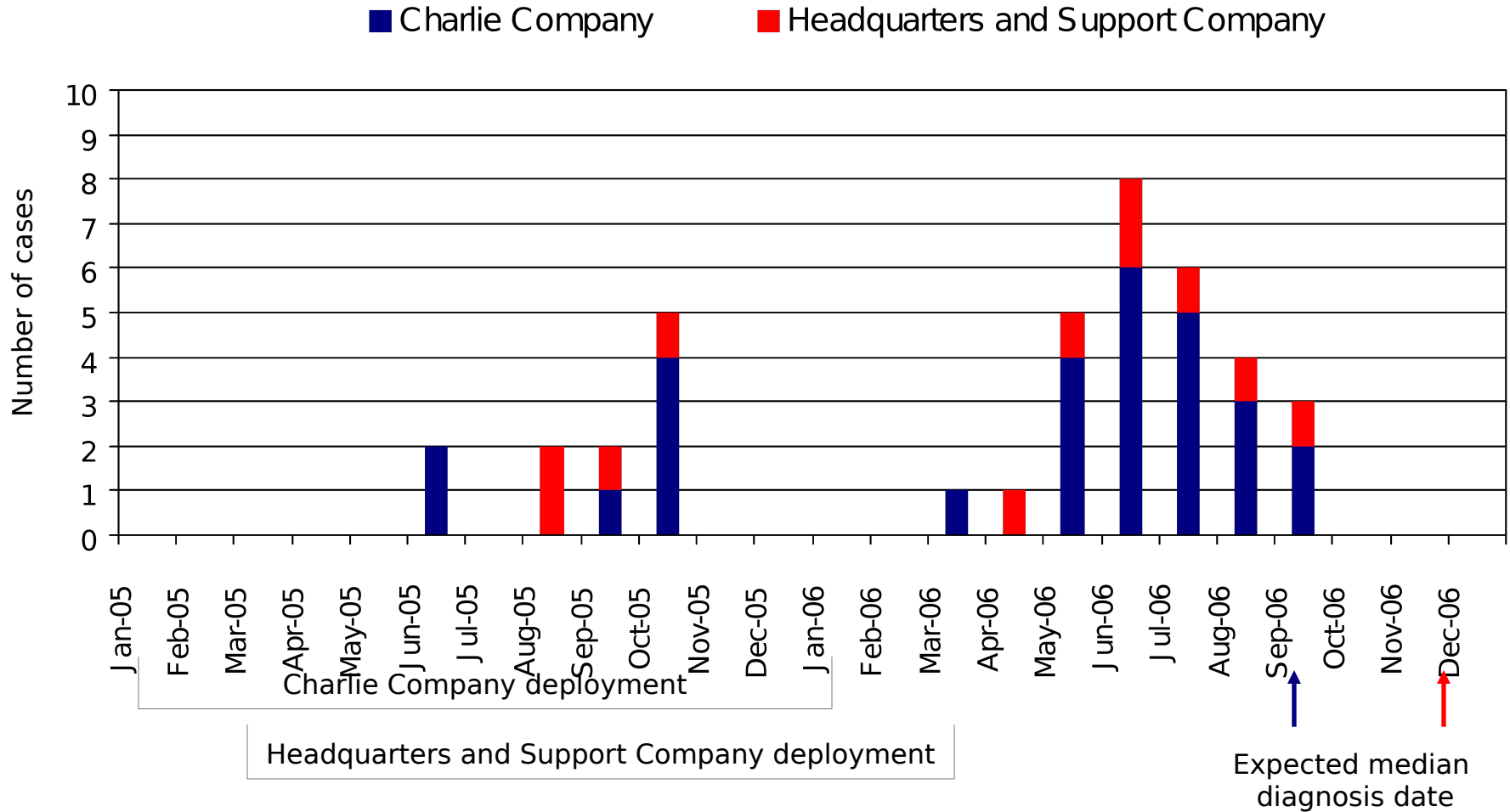
# PQ Intervention

- Presumptive anti-relapse therapy
  - Recommendation made by COL Alan Magill, Chair, US Army Office of the Surgeon General Malaria Advisory Board
  - Prevent relapse of suspected or possible infections
  - 30 mg daily for 14 days under directly observed therapy\*

\*Hill et al. Primaquine: report from CDC expert meeting on malaria chemoprophylaxis I. Am J Trop Med Hyg. 2006 Sep;75:402-15.



# Malaria Cases by Month of Diagnosis Among 864<sup>th</sup> ECB (n=35)





# Factors Contributing to Outbreak

- Medical
  - Ordering of primaquine and distribution was left up to the company commander
  - Primaquine not individually prescribed during SRP for one unit
- Leadership
  - DEET, permethrin, and doxycycline not consistently issued prior to deploying
  - Doxycycline supply lapses in theater
  - Malaria prevention lacked command emphasis



# Limitations

- Non-anonymous survey
- Recall bias
- Case ascertainment limited for Soldiers who separated from the Army
- Outbreak notification limited to letters sent to last known postal address (not by Certified Mail)



# Recommendations

- Educate junior line commanders
- Use directly observed therapy
- Refine risk assessment/communication
- Continued support for development of vaccine and long acting anti-malarials



# Acknowledgments

- MAJ Chris Littell
- MAJ Alden Weg
- LTC Petrina Gavrilis
- LTC Andy Wiesen
- 864<sup>th</sup> Engineer Battalion Soldiers





BAYONET  
DRILL  
*Tonight!*

DON'T  
BE A  
DUMMY...

*avoid malaria!*

KEEP COVERED! USE REPELLENT!

**FIGHT THE PERIL BEHIND THE LINES**

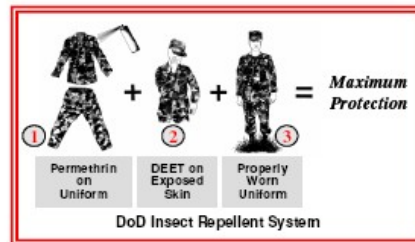


## Just the Facts...

## DoD Insect Repellent System

"Did you know that whenever nations send troops into battle, more troops are taken out of action by disease and non-battle injuries than are injured in combat? Many of the disease injuries result from germs passed by the bites of insects and their relatives. Don't let yourself be pestered by insects, or worse, become a casualty due to a bug-borne disease."

*Armed Forces Pest Management Board*



the uniform). If the IDA kit is not available, use the Aerosol Spray Can, NSN 6840-01-278-1336, 0.5-percent permethrin, one application of approximately ¼-can lasts through 5-6 washes. Treat your uniform PRIOR to deploying. Follow all label directions. Currently, uniforms can also be factory-treated via contract. Contact the Armed Forces Pest Management Board (AFPMB) for details.

### Q. How can I protect myself from being bitten by insects?

A. Help prevent the disease, pain, and annoyance caused by the bites of insects (such as mosquitoes and sand flies) and other arthropods (such as ticks and chiggers) by using personal protective measures (PPMs).

- For optimum protection, military personnel should utilize the **DOD INSECT REPELLENT SYSTEM**:

1. Treat your uniform (ACUs, BDUs, DCUs) with the standard military clothing repellent (permethrin). Use the IDA kit (NSN 6840-01-345-0237). This product is a permethrin impregnation kit that contains 40-percent permethrin. One kit treats one uniform, and the treatment lasts through approximately 50 washes (generally considered the combat life of the uniform). If the IDA kit is not available, use the Aerosol Spray Can, NSN 6840-01-278-1336, 0.5-percent permethrin, one application of approximately ¼-can lasts through 5-6 washes. Treat your uniform PRIOR to deploying. Follow all label directions. Currently, uniforms can also be factory-treated via contract. Contact the Armed Forces Pest Management Board (AFPMB) for details.



2. Apply a thin coat of the standard military skin repellent (DEET) to all areas of exposed skin. Use NSN 6840-01-284-3982, 33% controlled-release DEET lotion, one application protects for up to 12 hours depending on the climate. Follow label directions.

3. Wear your uniform properly; it acts as a physical barrier against insects. Wear the sleeves rolled down. Close all openings in your clothing that might provide access to insects: tuck pants into your boots, and undershirt into your pants. Wear your uniform loosely, because some insects, such as mosquitoes, can bite through fabric that is pulled tight against the skin.



# Methods Used to Identify Other Soldiers at Risk

- Identification of Soldiers PCSed from the 864<sup>th</sup> ECB – Email to 97 PM Chiefs
- Identification of Soldiers ETSed from the 864<sup>th</sup> ECB - Letters to 94 left the Army
- Inform National Guard and Reserve Surgeon of outbreak – other units were part of Task Force Pacemaker:
  - 391st (Reserves out of Ashville, North Carolina - A Co.)
  - 926th (Reserves out of Huntsville, Alabama – C Co.)
  - 298th (National Guard out of Pearl City, Hawaii).
  - 82nd Airborne Division was attached to the Task Force to provide security